CUMULATIVE IMPACT ANALYSIS: A SIMPLE MODEL FOR LOCAL GOVERNMENT RESERVOIRS AND WITHDRAWALS IN GEORGIA

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Abstract. A simple model is presented for consideration in the evaluation of cumulative impact analysis of water supply reservoir projects and other local government water supply projects proposing transfers out of basin or for consumptive use within Georgia. The approach is presented for Georgia's Altamaha, Oconee and Ocmulgee River Basins, but could be used for other river basins within the state.

INTRODUCTION

In recent years, there have been suggestions or requests for a cumulative impact analysis of proposed water supply reservoirs by environmental groups and federal agencies with regulatory authority over the Section 404 Clean Water Act permitting process. To date, no guidance or example of a cumulative impact analysis has been produced to directly relate to water supply reservoir projects in Georgia. The regulatory agencies may find that a specific impact is less than significant within its jurisdictional analysis, but the same action on a regional or basin scale may contribute to or create a significant cumulative effect.

A cumulative impact analysis should consider past, present and future actions, including projects currently under review. There are a large number of parameters that could be addressed for potential impacts. For local government water supply reservoir projects in Georgia, the parameters to be addressed would typically include all of the environmental parameters that are currently considered by the Savannah District Corps of Engineers in the Section 404 permitting process. Examples include wetlands acreage, riverine habitat, endangered and threatened species, water quality, and flow regime alterations. It could also include the U.S. Environmental Protection Agency Region IV (USEPA) National Environmental Policy Act (NEPA) review list of environmental parameters. The U.S. Fish and Wildlife Service (USFWS) has a proposed set of streamflow statistics that could also be included.

All local government water supply reservoir projects constructed or proposed to be constructed in Georgia since 1980 provide for minimum low flow protection, water supply storage for existing and future needs, habitat for aquatic life, and some recreational benefits. They serve the needs of people and thus population of the area is an important factor. Another important parameter is the amount of consumptive loss from the river system resulting from use of the water supply storage for drinking water, irrigation of urban landscaping, and agricultural irrigation. The consumptive use or withdrawals from the river minus returns back to the river are therefore another important parameter. Water supply reservoirs include evaporative losses, and should also be considered for Georgia.

All of these plus additional hydrologic and environmental parameters could be included into a cumulative impact analysis. The problem is that datasets do not exist to cover the various time frames representing existing, current and future conditions for these parameters. Statements about trends in land use (wetland acreage, forest land, etc.) are more difficult to make because the databases were created with different methods or under different hydrologic conditions. Therefore even when datasets are available they often cannot be used for meaningful analyses.

The effort can seem overwhelming and progress toward development of a cumulative impact analysis has not moved forward. Significant resources are required to develop the datasets at the various time intervals of desired use. Some historical datasets do not exist and often cannot be recreated. What is needed is a more simple model that can allow the effort to move forward.

BACKGROUND

Georgia has experienced numerous droughts over the period from 1980 to 2002. The droughts of 1981, 1986, 1988 and 1998 through 2002 have significantly reduced water availability to many communities. The Year 2000 drought impacted several communities within the Oconee and Ocmulgee River Basins. Several communities in the basins are proposing the water supply reservoir projects to meet future population growth needs and to drought-proof their communities.

The three river basins were selected because of the one recently constructed and five proposed water supply reservoirs within the basins. These include:

- Recently constructed Bear Creek Reservoir in Jackson County (Oconee Basin)
- Proposed High Shoals Reservoir in Oconee County (Oconee Basin)
- Proposed Tussahaw Creek Reservoir in Butts and Henry County (Ocmulgee Basin)
- Proposed Hard Labor Creek Reservoir in Walton County (Oconee Basin)
- Proposed Bear Creek Reservoir in Newton County (Ocmulgee Basin)
- Proposed Cedar Creek Reservoir in Hall County (Oconee Basin)

The Oconee and Ocmulgee Basin headwaters originate southeast of the Metropolitan Atlanta Region and drain to the Altamaha River Basin and to the Atlantic Ocean. The local government existing and proposed water supply reservoirs within the Altamaha River Basin comprise about 13 percent of the total reservoir acreage in the basin based on current Georgia EPD data. There have been some concerns relating to development of water supply reservoirs in the upper portions of the Altamaha and the potential impacts to downstream Altamaha River and its estuary.

The Lower Altamaha River Basin encompasses 2870 square miles and is formed by the confluence of the Ocmulgee and Oconee Rivers near Lumber City. The Altamaha River flows in a southeasterly direction for 125 miles before emptying into the Atlantic Ocean near Darien. The Oconee River Basin encompasses 5320 square miles and flows in a southerly direction for 226 miles from the confluence of the North and Middle Oconee Rivers near Athens, through Georgia Power Lakes Oconee and Sinclair to the Altamaha River. The Ocmulgee River Basin is located west of the Oconee River Basin and encompasses 6080 square miles. It flows through Georgia Power Lake Jackson to the Altamaha River. The entire Altamaha River Basin has 14,270 square miles and is the largest river basin in Georgia. Table 1 lists the eight USGS long-term gages that were selected to divide the system into reaches.

METHODOLOGY

All local government water supply reservoir projects in Georgia must address future population projections as part of a Federal Clean Water Act (CWA) Section 404(B)(1) guidelines needs documentation. The process proposed for the simple model for Georgia would be to compile and sum all existing and future projected populations of the local government jurisdictions with surface water supplies located within the river basin proposed for new water supply reservoirs out to identical timeframes. The population projections would be performed for the situations with and without proposed new water supply reservoirs. A smaller water supply reservoir project would serve a projected population for a shorter timeframe. Likewise, a larger water supply reservoir would serve a larger projected population, and therefore a longer forcasted timeframe. For each new or expanded surface water withdrawal or new water supply reservoir, there is an associated population forecast. Efficient water use and effective water conservation measures would be assumed to be in place to help existing sources provide for additional population. If significant industry is to be supplied, there will also be an additional equivalent population associated with it. The increased population from existing permitted surface water withdrawals would be treated as current condition. For any new surface water withdrawal or reservoir project proposed in the Ocmulgee, Oconee or Altamaha River Basins, the cumulative impact analysis would be completed by quantifying the population increases impact on 7Q10

Table 1. Reach and USGS Gages For Altamaha, Ocmulgee and Oconee River Basins

USGS Gage	Gage Located Downstream of Reach	Description of USGS Gage
02218300	OCO 1	Oconee River Near Penfield
02223000	OCO 2	Oconee River At Milledgeville
02223500	OCO 3	Oconee River At Dublin
02210500	OCM 1	Ocmulgee River Near Jackson
02213000	OCM 2	Ocmulgee River At Macon
02215500	OCM 3	Ocmulgee River At Lumber City
02225000	ALT 1	Altamaha River Near Baxley
02226000	ALT 2	Altamaha River At Doctortown

and long-term average stream flows and impact on runoff yield.

Census population by county was readily obtained for historical and current conditions in Georgia. The County level population datasets were aggregated for the appropriate river basin. The change in population associated with future water supply withdrawal and reservoir projects can then be related to river flow statistics. For this model, annual mean stream flow records for the period of record, and seven-day ten-year (7Q10) recurrence interval low flow statistics were used. Period of record USGS stream gage data through water year 2000 was used to obtain annual average stream flows for each of the eight reaches.

For each basin reach, population and irrigation acreage determine the amount of consumptive surface water use. Actual census population by county data was used for years 1980 and 2000. Whole county data was roughly prorated by land area draining to each of the eight respective reach designations and then aggregated by reach. The same process was used to compile Year 2001 permitted agriculture surface water irrigation acreage by reach. Year 2001 permitted acreage includes all irrigation from surface water in the basins that have been permitted by EPD through 2001, plus the acreage associated with concurrence letters through 2001 for proposed irrigation permits.

Actual consumptive surface water use for Year 1980 was not readily available, but a current set of actual Year 2001 consumptive surface water use by entities regulated by GA EPD was available. For an extremely conservative representation of a worst case situation, consumptive water use was assumed to be zero in 1980. Therefore, all surface water consumptive use through the actual reported Year 2001 withdrawals and returns were assumed to be from increases in population and agriculture irrigation acreage since 1980. Agriculture surface water use was estimated at 0.06 MGD per 100 acres, representing 8 inches per year of supplemental irrigation per 100 acres. The permitted surface water withdrawals and returns were assigned to one of the eight reaches. Year 2001 actual reported data will also represent a worst case situation for normal water consumption through Year 2000, in that is was a dry year and covers the entire service year 2000 population.

All municipal and industrial water withdrawal and return data was obtained from the EPD Municipal and Industrial Water Resources Program as of May 21, 2002. Georgia Power provided additional information on June 7, 2002 to supplement the data for consumptive use reporting.

The municipal and industrial (M & I) annual average consumptive use (withdrawals minus returns) by reach were then combined with the agricultural consumptive use figures to derive a total annual average consumptive surface water use estimate by each of the eight reaches. The individual reach figures were then combined to represent a cumulative figure, based on location within the three river basin system. For example, the results for reaches OCO 1, OCO 2, and OCO 3 were combined to derive the cumulative annual average consumptive surface water use at the bottom of reach OCO 3 on the Oconee River. Results of OCM 1, OCM 2, and OCM 3 were combined for the Ocmulgee River at Lumber City, and OCO 3, OCM 3, ALT 1, and ALT 2 were used to provide the cumulative annual average consumptive surface water use for the Altamaha River at Doctortown (ALT 2).

Table 2 shows the annual average surface water cumulative consumptive use by reach for current conditions, and the portions associated with municipal and industrial use versus agricultural irrigation use. For the Upper Oconee River Basin and the Upper Ocmulgee River Basin reaches, agriculture water use is less significant. Adjustments for agriculture use must be made for the analysis of future downstream impacts from M&I water supply reservoir and withdrawal projects, however, for the downstream reaches. The Altamaha River system gained an annual average of

Table 2. Total Annual Average Consumptive Surface Water Use By Reach (Cumulative M & I Versus Ag Through Year 2001)

	Year 2001 Annual Average Cumulative Consumptive Water Use (MGD)		
Reach	M & I	Ag	Total
OCO 1	10.7	2.0	12.7
OCO 2	15.5	7.0	22.5
OCO 3	16.3	12.6	28.9
OCM 1	-44.0	2.3	-41.7
OCM 2	37.3	4.8	42.1
OCM 3	0.5	60.4	60.9
ALT 1	10.1	90.5	100.6
ALT 2	-22.7	103.8	81.1

22.7 MGD of surface water from M&I use, but had an estimated loss of 103.8 MGD from agriculture use in 2001. This total resulted in a cumsumptive use of 81.1 MGD from the Altamaha River system for Year 2001.

Another parameter evaluated for this cumulative impact analysis model was annual runoff yield. The annual runoff yield in MGD per square miles, represents the water availability at any given time. The information was derived from USGS stream flow data for the eight gages and the drainage area associated with each gage.

CURRENT CONDITIONS ANALYSIS

The current Year 2001 actual reported cumulative consumptive surface water use was compared with the period of record stream flow statistics to provide the cumulative impact from historical to current conditions. The results provide insight into the impact that current consumptive surface water use has on stream flows at any given reach of the Altamaha system. Current levels of consumptive surface water use from municipalities, industries, and agriculture are less than 1 percent of the long term average Altamaha River Basin flows.

Within the Ocmulgee River Basin, the total consumptive use from all EPD permitted surface water sources comprises 1.7 percent of long-term average stream flows. In the Upper Ocmulgee River Basin reach above Jackson, Georgia, there is an actual gain of 3.7 percent of long-term average stream flows due to the basin transfers by some metro Atlanta counties from the Chattahoochee River Basin to the Upper Ocmulgee River.

The annual average cumulative total consumptive surface water use figures compared to annual 7Q10 stream flow statistics show a reduction of up to 5.6 percent of the total Altamaha River Basin system dry condition stream flows. The most significant current impact on annual 7Q10 is a 15.9 percent consumptive loss for the Ocmulgee River Basin at Macon.

The seasonal cumulative impacts on long-term average stream flows were evaluated in a similar manner. The differences in agriculture surface water consumptive use by months and seasons are huge. The power generating facilities with cooling water towers, such as Plant Scherer in reach OCM 2 and Plant Branch in reach ALT 2, account for much of the M & I variations in withdrawals and returns. Power generation was significantly higher in the months of July and August of 2001 as reported by Georgia Power for Plant Scherer. The other municipal and industrial users have slightly higher consumptive surface water use in the months of June, July and August of 2001. Agriculture use follows a pattern with June and July being the months of largest agriculture irrigation use. In reach OCM 3, June 2001 agriculture irrigation use was estimated at 244.9 MGD as compared to 1.3 MGD for December 2001.

The current cumulative impact of seasonal consumptive surface water use on long-term monthly average stream flow shows impacts ranging from –0.2 to 8.0 percent of monthly average long-term flows for the total Altamaha River Basin system at ALT 2. In the month of July, when the 8 percent occurs, the farming growing season is well under way and represents 27.4 percent of all Year 2001 agriculture irrigation water use for the Altamaha River Basin system.

Agriculture water use in June far exceeds the municipal and industrial consumptive use in June. The variations in monthly municipal and industrial use show increases in summer and fall months, and randomness due mostly to the power facilities with cooling towers.

Long-term annual average period of record flows through water year 1980 were used for the historical dataset. The period of record annual average stream flows through water year 2000 were used for the current dataset. The ratio of long-term average annual stream flow to drainage area provides the cumulative annual average runoff yield in MGD / SQ. MI.

The current Altamaha River Basin system reflects a decrease of 0.01 MGD per square mile, or approximately 136 MGD for the 13,600 square mile drainage area down to the Doctortown gage on the Altamaha River. This impact is a result of a dryer climate for the Year 1981 through 2000 period, evaporation, and all water consumption (permitted and unpermitted) within the Altamaha River Basin system.

None of the parameters: population, consumptive use, stream flow statistics, or runoff yield, by themselves, can address the cumulative impact analysis needs for local government water supply withdrawal and reservoir projects in Georgia. However, all of them used in combination for any proposed water supply reservoir project for any purpose within any unregulated river basin in the state, can provide a reasonable analysis of worst case present conditions. The population change from the baseline or historical Year 1980 to the current Year 2000 can be linked to the other parameters for this purpose also.

The cumulative population increase at each of the eight Altamaha River Basin locations representing historical (Year 1980) to current (Year 2000) was then computed and compared with the flow statistics parameters for the current conditions. The Table 3 cumulative flow statistic parameters are computed per each 100,000 population in the Altamaha Basin for all purposes since Year 1980, for each of the eight reaches of the Altamaha River Basin system.

This simple model overstates the actual impacts of the existing water supply reservoirs built by local government for municipal and industrial use. For example, industrial return flows are not all required to report, so consumptive loss is overstated. Often withdrawals from rivers to reservoirs are made simply to store the water for flow augmentation or consumptive use at a later date, but are included as consumptive loss impacts with the reported withdrawal. Several drought years are reflected in the runoff yield assessment. The impacts of withdrawers using less than 100,000 gpd that are not required to obtain permits from Georgia EPD are also reflected.

FUTURE CONDITIONS ANALYSIS

For any proposed surface water withdrawal or water supply reservoir to be located within the Altamaha River Basin system, the cumulative impacts will be added to current conditions to determine the downstream cumulative impact. If a proposed new withdrawal or water supply reservoir includes agriculture irrigation water use, the future condition impacts per population are assumed to be equal to the current condition impacts per population as a worst case. It is worst case because the grandfathering of irrigation withdrawal permits ended in July 1991 and reflected all existing agriculture use existing as of 1988.

Table 3. Cumulative Impact Analysis For Current Conditions Altamaha River Basin Per 100,000 Population Served

Altamaha River Basin Reach	Cumulative Loss of Water As Percentage of Long-Term Average Flow (%)	Cumulative Loss of Water As Percentage of 7Q10 Stream Flow (%)	Cumulative Loss of Annual Average Runoff Yield (MGD / SQ. MI.)
OCO 1	1.65	15.55	0.103
OCO 2	0.70	8.80	0.044
OCO 3	0.59	4.62	0.053
OCM 1	-0.65	-3.35	0.000
OCM 2	0.39	2.61	0.005
OCM 3	0.26	1.13	0.003
ALT 1	0.15	0.96	0.002
ALT 2	0.10	0.65	0.001

If a proposed new withdrawal or water supply reservoir is for municipal and industrial use only, then Table 1V would be used. This table adjusts for the impact of agriculture water use and reflects the streamflow protection provisions associated with any future water supply reservoir or withdrawal project proposed in the Altamaha River Basin of Georgia.

The incremental cumulative impacts from future water supply reservoirs and surface water withdrawals per population in the Altamaha River Basin will be offset partially by more protective measures implemented by EPD. In the future, there will be improvements seen in the operation of new and expanded permitted withdrawals in Georgia. Georgia EPD will implement this with higher minimum instream flow requirements. The May 2001 Georgia DNR Interim Instream Flow Protection Strategy will require 30 percent of the mean annual average flow or actual flow, whichever is less, to pass the withdrawal intake point. Previously, the requirement was the lesser of 7Q10, or actual flow, or even no minimum flow requirement in some grandfathered situations. For new water supply reservoir projects with withdrawal or Section 404 permit applications submitted after April 1, 2001, the minimum release from the reservoir will be the lesser of the monthly 7Q10 or the inflow to the reservoir. Previously, the requirement was the lesser of the annual 7Q10, or actual inflow. Other options for releases that will typically increase the minimum flows are also available under the interim strategy.

Georgia Power has adjusted release schedules to improve habitat for the robust redhorse at Lake Sinclair on the Oconee River and at Lake Jackson on the Ocmulgee River. These variable minimum flow release provisions provide an opportunity for decreasing downstream effects on aquatic habitat, water quality, and sediment transport.

Georgia EPD also intends to require wetland and other environmental mitigation requirements to be completed with each new permitted water supply reservoir and withdrawal intake, including expansions, to help offset these impacts. This, combined with Georgia DNR's May 2001 additional downstream interim flow protection requirements, should improve aquatic life habitat. Also, Georgia EPD will continue to require water quality standards to be met for all future projects.

This cumulative impact analysis does not attempt to address the flow alterations and fragmentation of the stream river system, nor the functions lost from free flowing rivers. Although it may be an additional concern for some regions, it is not considered to be a significant impact for the relatively large Georgia Altamaha River Basin. Striped bass, sturgeon and other fish species are free to swim upstream as far as they would dare to go, and are not restricted by dams or intake structures on the Altamaha system below Juliette on the Ocmulgee River and Sinclair Dam on the Oconee River. The temporal and spatial extent of spawning activities on the Altamaha River system are not impacted by the small flow changes seen to date or anticipated in the future. The Georgia Altamaha River system remains the most productive freshwater flowing stream system in the state.

RECOMMENDATIONS

This simple cumulative impact analysis tool, while specific to the Altamaha Basin, can be applied, with basin specific information, to other unregulated river basins in the State of Georgia. Hopefully, it will also assist the agency permit review process in the State of Georgia.

Significant resources are required to develop the datasets at the various time intervals of desired use. Some historical datasets do not exist and often cannot be recreated. A dedicated source of water resources funding is required to provide comparable datasets for an expanded set of parameters of interest for future cumulative impact analyses.

Table 4. Cumulative Impact Analysis Future M & I Water Supply Withdrawals And Reservoir Projects In Georgia Within The Altamaha River Basin Per Each Additional 100,000 Population Served

Altamaha River Basin Reach	Cumulative Loss of Water As Percentage of Long-Term Average Flow (%)	Cumulative Loss of Water As Percentage of 7Q10 Stream Flow (%)	Cumulative Loss of Annual Average Runoff Yield (MGD / SQ. MI.)
OCO 1	1.35	13.12	0.103
OCO 2	0.49	6.06	0.044
OCO 3	0.33	2.59	0.053
OCM 1	-0.68	-3.52	0.000
OCM 2	0.35	2.31	0.005
OCM 3	0.00	0.01	0.003
ALT 1	0.02	0.10	0.002
ALT 2	-0.03	0.18	0.001

Georgia EPD actual reported water consumptive use data needs to be more readily available and assessable for use in future cumulative impact analyses.

The agency or stakeholder must supplement this simple model with more detailed data and analysis concerning the issue or parameter of specific concern or interest. These same parameters can be used to relate to any other environmental, social or economic parameter of interest to a stakeholder or jurisdictional agency.

SELECTED REFERENCES

Council of Environmental Quality Regulations 40CFR1508 et seq al.

Office of Planning And Budget – Census Population By County

USGS Water Resources Data – Georgia, 2000